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Vocational Series

AIRCRAFT MAINTENANCE 22 - 32

(September, 1969)

Province of Alberta

Department of Education

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FOREWORD

During the past decade aircraft have become the major challenge to other modes of transportation both in the movement of people and goods. With the present economic explosion, especially in the northern areas of Canada, the aircraft is quickly becoming the most efficient, if not the only satisfactory means of moving consumer goods and equipment.

Statistics show that during the 1964-69 period, the total number of aircraft operating within the Western Region, comprising Alberta, Yukon, and part of the N.W.T., increased by 77 per cent. In this same period, the increase of Aircraft Maintenance Engineers was only 17 per cent. Total aircraft registered in Canada as of December, 1968, was 9,973, with the Western Region accounting for approximately 1,700 of this total.

The demand is rapidly increasing for expertly trained aircraft maintenance personnel who possess a sound educational background. This need has become more acute with the arrival of pressurized/turbine aircraft and helicopters.

This curriculum guide has been prepared for use in those high schools that have been approved by the Department of Education as possessing the facilities, equipment and qualified staff to teach the program successfully.

The content of this two-year program provides the basic formal training towards a Department of Transport Category "A" Aircraft Maintenance Engineer license. Graduates can be reasonably assured that they will have an opportunity to take advantage of and to succeed within the field of Civil Aviation, not only in the Western Region but also the rest of Canada.

GENERAL OBJECTIVES

1. To acquaint the student with the aviation industry and the occupational opportunities that exist in this particular field.

2. To provide the student with essential skills and basic knowledge that will make him adaptable to employment conditions in the aviation industry.

3. To develop the students aptitude in the field of aircraft maintenance and technology so that he will be encouraged to take further training in this field.

4. To provide the student entering aircraft Maintenance Engineer apprenticeship with the technical background for accelerated advancement on the job.

5. To utilize the powerful motivation inherent in this subject by making the student aware of the importance of other school subjects in the study of aviation.

6. To assist the student in the development of desirable work habits, a sense of responsibility and the ability to cooperate with his associates.

7. To instill a sense of safety and a respect for sound workmanship, both of which are essential in this occupational field.

GENERAL INFORMATION

1. Time Allocation:

It is recommended that in the Aircraft Maintenance 22 and 32 courses, 40% of the time be given to theory and 60% to shop practice. Maximum number of hours devoted to this program would be 1,064. For those schools that offer the "32" course for 15 credits, the total number of hours would be 930.

2. Safety Program:

Every shop must have an effective safety program. In the aircraft shop particular attention must be given to incorporating the safety measures that are used in industry,

notably machines used with adequate guards; cleanliness of shop and personnel maintained at a high standard; students properly clothed for their work. Shop organization must be well developed to ensure a stress on this important phase of the shop program.

A good safety program features the following devices: regular, consistent and thorough instruction; constant vigilance and checking by instructor; safety posters; student safety committee; adequate first-aid equipment; instructor trained and up-to-date in first-aid methods; dynamic color painting of machines and equipment; adequate working space about machines; safety lines on floor around machines; routine report on accidents however minor; machines and tools in approved working condition and a safety conscious group of students and instructor.

3. Instructor's Records:

The instructor should keep accurate records of:

a. Student enrolment and attendance
b. Customer and student accounts
c. Student work activity
d. Theory covered
e. Tests given
f. Student achievement, aptitudes and attitudes
g. Up-to-date inventory of all equipment.

4. Student Records:

Instructors should ensure that the student develops and maintains a neat and accurate record of:

a. Notes on theory
b. Daily shop activities (time cards).

5. Enrolment:

It is recommended that the maximum enrolment should not exceed 15 students for any laboratory or shop class; however, two classes may be combined for the presentation of theory.

6. Guidance and Vocational Information:

Instructors must assume responsibility in their trade area to ensure that students and school guidance officials are aware of the local situation. Instructors

through the Principal have some responsibility for student placement. It is advisable that instructors be active, interested and informed.

7. Flight Experience:

Each student should be provided with three hours flying time in order to obtain familiarity with an aircraft in flight. Specific learning will take place through demonstrations of:

a. Effects of controls
b. Airplane attitudes and movements
c. Engine and flight instrument readings
d. Aircraft radio procedures
e. In-flight compass swinging
f. In-flight inspection.

The main objective of this flight experience is to ensure that the student has a highly-developed sense of responsibility and safety awareness, factors which are of the highest importance in aircraft maintenance.

8. Apprenticeship Time Credit:

Suitable practical time credits may be given towards obtaining an Aircraft Maintenance Engineer's License Category A or B, and the Department of Transport Examinations may be waived on the successful completion of the program.

INSTRUCTIONS ON THE USE OF THE FOLLOWING GUIDE

The course outline is divided into two columns designated: Topic and/or Operation and Related Information. The first column outlines the type of activity performed by the students in the shop. The second column refers to the essential knowledge upon which a well educated employee in the aircraft industry will depend to adequately carry out the mutual activities outlined in the first column. The second column also lists numbers which correspond to References other than the prescribed texts. They are listed on the following page.

TEXTS

Code:
Reference - R
Chapter - C

Aircraft Maintenance 22 and 32

R-4 McKinley, J. L. and R. D. Bent (Northrop Institute of Technology). *Basic Science for Aerospace Vehicles*, Third edition. McGraw-Hill, 1963.

R-7 McKinley, J. L. and R. D. Bent (Northrop Institute) of Technology). *Maintenance and Repair of Aerospace Vehicles*. McGraw-Hill, 1967.

Aircraft Maintenance 32

R-6 McKinley, J. L. and R. D. Bent (Northrop Institute of Technology). *Powerplants for Aerospace Vehicles*. McGraw-Hill, 1965.

REFERENCES

R-1 Van Deventer, C. N. *An Introduction to General Aeronautics*. General Publishing, Don Mills, 1965.

R-2 Department of Transport, Civil Aviation Branch, *Study and Reference Guide for Aircraft Maintenance Engineer License*, January 1963.

R-3 *Engineering and Inspection Manual*, Parts I, II, III. Queen's Printer, Ottawa.

R-5 McKinley, J. L. and R. D. Bent (Northrop Aeronautical Institute). *Electricity and Electronics for Aerospace Vehicles*. McGraw-Hill, 1961.

R-8 Sheet Metal Vol. I, E.A.A. *How To* series. Experimental Aircraft Association, Inc., P. O. Box 229, Hales Corners, Wis., 53130, 1968.

R-9 Sheet Metal, Vol. II, E.A.A. *How To* series. Experimental Aircraft Association, Inc., P. O. Box 229, Hales Corners, Wis., 53130, 1968.

R-10 *Bell Helicopter, Description and Maintenance*. Bell Aircraft Corp.

R-11 Aircraft Circular AC 43.13-1. *Aircraft Inspection and Repair*. Supt. of Documents, Washington, D.C.

R-12 Aircraft Circular AC 43.13-2. *Aircraft Alterations*. Supt. of Documents, Washington, D.C.

R-13 Federal Aviation Regulation Part 23 - Airworthiness Standards for Normal Utility and Aerobatic Aeroplanes. Supt. of Documents, Washington, D.C.

R-14 Air Navigation Orders. Queen's Printer, Ottawa.

R-15 Air Regulations. Queen's Printer, Ottawa.

R-16 Casamassa, J. V. and R. D. Bent (Northrop Institute of Technology. *Jet Aircraft Power Systems*. Third edition. McGraw-Hill, 1965.

AIRCRAFT MAINTENANCE 22

(20 credits)

Topic and/or Operation	Related Information
Unit I: Introduction - 5 hours	
Opportunities in the field of aeronautics.	Growth of the industry. R-1. Occupations. Aircraft Maintenance Engineer. (A.M.E.). R-2. R-3, C-C. D.O.T. approved training programs.
Unit II: Basic Aeronautical Theory - 40 hours	
Principle parts of the aircraft.	Fuselage. Wings. Control surfaces. Landing gear. Propellor. Rotors.
Standard aircraft fasteners and fittings.	Basic differences. R-7. AN bolts, washers, nuts, piping and associated parts. Military specifications. Other standards for aircraft hardware. R-4.
Standard atmosphere.	I.C.A.O. standard. R-4, C-1. Gas laws. R-4, C-1. Density of air. R-1, C-3. R-4, C-2. Inertia of air. Temperature of air. R-4 C-2.
Relative motion.	Wind tunnels Errors. Balance.

Topic and/or Operation	Related Information
Fluid flow.	Streamlines. R-4, C-2. Flat plate. R-4 C-2. Sphere. R-4 C-2. Streamline shape. R-1, C-4. Fineness ratio.
Drag.	Factors affecting. R-1, C-4. Drag formulae. R-1 C-4. Pressure waves. R-4 C-2. Speed of sound. R-4 C-2. Transonic and super-sonic regions. R-4, C-3.
Lift.	Factors affecting. R-4, C-2. Lift formulae. R-4, C-3. R-1, C-4. Bernoulli's theorem. R-4 C-2. Center of pressure. R-4, C-2. Aspect ratio. R-4, C-3. Types of airfoils. R-4, C-2 and 3.
Viscosity of air.	Skin friction. R-4, C-2. Boundary layer and control. R-4, C-2. Transition point. R-4, C-2. Reynolds number. R-4, C-3.
Stalling and landing speeds.	Angle of attack. R-4, C-2. Stalling angle. Optimum angle. Wing loading. Stalling speed. Shock waves and shock stall. Mach and critical mach number. Sweepback effect.
High lift and anti-lift devices.	Variable camber. R-4 C-4. Types of flaps. R-4, C-3. Leading edge slats. R-4, C-3. Spoilers and fences. R-4 C-4.
Types of drag.	Form. R-4, C-2. Aerodynamic cleanliness. R-4, C-2. Parasite. R-4, C-2. Wing tip vortices. R-4, C-3. Wing and tip shapes. R-4, C-3.

Topic and/or Operation	Related Information
Level flight.	The four forces. R-4, C-2. Conditions of equilibrium. R-1, C-5. Horizontal stabilizer and loads. R-4, C-4.
Trimming devices.	Fixed tabs. R-4, C-4. Adjustable tabs. Adjustable trailing edges. Trimming tabs. Adjustable horizontal stabilizers.
Controls.	Axis. Movements. R-4, C-4. Types of controls. R-4, C-4. Balance and servo tabs. R-1, C-5. Power assisted controls. R-4, C-8. Balancing, mass and aerodynamic. R-1, C-5. Flutter and effects. (Kermode) Control at low speed. (Kermode) Frise and differential ailerons. R-1, C-5. Flying tails (Stabilizer). R-1, C-5.
Stability.	Static. R-1, C-5. Dynamic. R-1, C-5. Lateral stability methods. R-1, C-5. Longitudinal stability methods. R-1, C-5. Directional stability methods. R-1, C-5. Spiral instability. (Kermode) Oscillatory instability, R-1, C-5)
<u>Unit III: Flight Instruments</u> - 15 hours	
Gyroscopic instruments.	Principles of gyroscope. R-5, C-15.

Topic and/or Operation	Related information
	Construction, features and functions of: 1. Turn and bank indicators 2. Slip indicators 3. Artificial horizons 4. Directional indicators. R-1, C-10.
Diaphram instruments.	Construction, features and functions of: R-5. 1. Pilot-static heads. R-1, C-10. 2. Air speed indicator. R-1, C-10. 3. Altimeters. R-1, C-10. 4. Machmeters. R-5, C-20. 5. Rate-of-climb indicator. R-1, C-10.
Inspection and servicing.	Removal and installation. Routine inspection. Calibration. Leak and pressure tests. Trouble shooting.
Magnetic direction indicator.	Types, construction, features and functions. R-5, C-15. R-1, C-10. Errors. Variations and deviation.
Inspection and servicing.	Removal and installation. Routine inspection.
Compass swinging.	D.O.T. requirement. R-3. Co-efficient method. Landing compass method. Compass base method. In-flight method.
Automatic pilot.	(Reference and introduction only). R-5, C-21 and 23.

Topic and/or Operation	Related Information
Unit IV: Structures - 20 hours	
Types of structures.	Primary. R-4. Secondary. Aircraft major component parts. Stations and locations.
Structural members and stresses.	Major loads and stresses 1. Tension 2. Compression 3. Bending 4. Shear 5. Torsion. Stress-strain graphs interpretation. Load factors. Factors of safety. Deflection of beams.
Frameworks.	Perfect frames. Redundant frames. Deficient frames.
Fuselages.	Component parts. R-4. Pratt truss. Warren truss. Monocoque and semi.
Wings and stabilizers.	Cantilever and semi-cantilever. Component parts. Metal and wood stressed skin. Fabric covered framework. Mono and multi spars. Box and "D" spars.
Floats and hulls.	Types of aircraft used on. R-4, C-8. Design and buoyancy requirements. Component parts terms and definitions. Contours of floats.

Topic and/or Operation	Related Information
Skis.	Types. Rigging and aerodynamic requirements. R-3.
Engine mounts.	Types. R-6. Firewalls, requirements and materials. Load distribution. Dynamic suspension.
Engine cowling.	Component parts. R-6. Requirements. Construction and materials.
Unit V: Aircraft Woodwork - 40 hours	
Aircraft wood.	Hardwoods and softwoods. R-7, C-2. Terminology for woods. Requirements for aircraft wood. Plywood for aircraft.
Glues and gluing procedures.	Types of glues for aircraft. Mixing dry-resin glue. Moisture content of wood. Proper gluing conditions. Gluing pressure. Pressing time. How pressure is applied. Cleanliness in gluing.
Basic hand tools - care and use.	Layout and measuring tools. Cutting tools. Hammers. Boring and drilling tools. Clamps. R-7, C-1.
Power tools.	Bench saw. Band saw (wood and metal). Jigsaw. Jointer. Disc sander.

Topic and/or Operation	Related Information
Simple exercises using hand and power tools.	Nails and screws: R-7, C-2. 1. Types and identification 2. Guide and clearance holes 3. Countersinking and nailing.
Wood splicing.	
Rib construction.	
Plywood skin repairs.	Types of plywood patches.

Unit VI: Fabric Covering, Finishing and Repairs - 40 hours

Materials.	Terms and definitions R-7, C-3. Types of fabrics and grades. Tapes, threads, and cord. Grommets and hardware.
Hand stitching.	Baseball stitch. R-7, C-4. Lock knots. Spacing.
Repair by patching.	Limitations. Procedure. Sewing tears. Surface patch. Sewed-in patch.
Covering aircraft components.	Tools and equipment. Types of machine sewn seams. Doped seams. Envelope cover. Blanket cover. Interrib bracing. Rib lacing or rib stitching. Surface tape application. Installation of grommets inspection rings and patches.
Dope and doping.	Types and composition. Safety features. Dope application 1. Brush 2. Spray gun.

Topic and/or Operation	Related information
	Doping schemes. Faults, causes and remedies. Safety precautions.
Lacquers and enamels.	Types and composition. R-7, C-4. Solvents and paint removers. Brush and spray uses. Faults, causes and remedies.
Finishing of metal aircraft and parts.	Corrosion protection. R-7, C-4. Removal of paint. Cleaning. Etching. Priming. Finishing.
Registration marks.	Required markings. Location. Size. Laying out letters and numbers.
Unit VII: Aircraft Metals and Heat Treatment - 50 hours	
Physical properties of metals.	Tensile strength. R-7, C-5. Strength/weight ratio. Hardness. Brittleness. Malleability. Ductility. Elasticity. Fatigue resistance.
Testing materials.	Tensile test: 1. Yield strength. 2. Ductility. 3. Elasticity. 4. Malleability Hardness test: 1. Correlation with tensile strength 2. Correlation with heat treatment

Topic and/or Operation	Related Information
	3. Brinell method. 4. Other hardness tests explained. Impact tests explained. Fatigue tests explained.
Ferrous metals.	Cast iron. R-7, C-5. Wrought iron. Carbon steels: 1. Low carbon 2. Medium number 3. High carbon. Alloy steels: 1. Chrominium 2. Nickel 3. Molybdenum 4. Manganese 5. Tungsten 6. Vanadium. Stainless steel: 1. Composition 2. Properties and uses.
Heat treatment of steel.	Annealing. Normalizing. Hardening. Tempering. Surface hardening.
S.A.E. steel numbering system.	Code structure.
Identification of steel.	Material, colour. Tests.
Non-ferrous metals; properties and uses.	Aluminum. R-7, C-5. Aluminum alloys. Magnessium alloys. Copper. Brass. Bronze and alloys. Zinc. Tin. Titanium. Beryllium. Columbium.

Topic and/or Operation	Related Information
Aluminum association numbering system.	Code structure.
Identification of aluminum alloys.	Material, colour. Tests.
Unit VIII: Plastics - 10 hours	
Materials, composition and uses.	Terms and definitions. R-7, C-17. Classification. Acrylic thermoplastic. R-9, C-12. Glass cloth and resin. Glass.
Fabrication of acrylic thermoplastic.	Forming. Cements and cementing. Drilling and buffing. Cleaning and polishing.
Acrylic window installation.	Temperature effect. Hole clearances. Tightening limits. Dimensions and limits.
Repairs.	Temporary. Surface patch. Plug patch. Limitations.
Glass windows, features and functions.	Installation. Heating. Cleaning and inspection.
Fabrication and repair of resin laminates.	Wet lay-up method. Metal bonding. Mat molded parts. Damage and repair.

Topic and/or Operation	Related Information
Unit IX: Aircraft Sheet Metal and Repair - 110 hours	
Aluminum alloys.	Types, composition and uses. R-8, C-2. Annealing and tempering. Solution and precipitation heat treatment. Storage and handling.
Solid rivets.	Types, materials and uses. R-8, C-6. Rivet code and identification. Temper designations. Heat treatment: 1. Salt baths. 2. Use of salt bath 3. Safety precautions. Age hardening: 1. Refrigeration 2. Alloys and treatment.
Riveting aluminum alloy.	Drilling rivet holes. Rivet lengths and cutting. Dimensions of upset rivets. Minimum rivet spacing. Hand riveting. Types, use and safety of pneumatic rivet guns. Sheet metal fasteners and hole finders. R-9, C-8. Squeeze riveting.
Rivet dimpling.	Uses and procedures. Hand and machine. Hot dimpling machines.
Special rivets and their uses.	Blind rivets, types and materials: R-8, C-7. 1. Identification code 2. Application. Explosive. Hi-shear. Riv-nuts and Chobert. N.A.C.A. riveting method.

Topic and/or Operation	Related Information
Fitting fabrication.	Minimum radius of bends. Layout fluids and simple geometry. Bending and bend allowance. Calculations and charts. Open and closed angles.
Uses of bending and forming machines.	Cornice brake. Forming rolls. Beading machine.
Use of cutting machines.	Aviation hand shears. Squaring shears. Hand nibbler.

Unit X: Welding Familiarization and Repairs - 50 hours

Oxyacetylene brazing and welding.	Equipment familiarization. R-7, C-6. Setting up equipment. Safety precautions. Adjusting pressures. Lighting and adjusting flame. Flame types. Backfire and flashback. Brazing technique. Welding technique. R-7, C-7. Shutting down welding outfit. R-7, C-6.
Making a sample oxyacetylene bead.	
Arc welding.	Equipment familiarization. R-7, C-8. Electrode types. Adjusting current. Polarity. Basic technique.

Topic and/or Operation	Related Information
Making a sample arc bead.	Types of steel tubing. Approved procedures for weld repairs. R-7, C-9. Controlling distortion. R-11.
Aircraft tubing repair.	
Unit XI: Aircraft Hydraulics - 50 hours	
Principles of hydraulics.	Power through hydraulics: 1. Power 2. Work R-7, C-13. 3. Force 4. Force per unit area (Pressure) 5. Horsepower. Characteristics of liquids: 1. Practical incompressibility 2. Effect of temperature on liquids 3. Pascal's law. Liquids in motion: 1. Friction 2. Law of conservation of energy. Performing work with a liquid. A simple hydraulic system.
Hydraulic pumps.	Hand pumps: 1. Single-acting hand pumps 2. Double-acting piston-displacement type Gear type pump. Vane-type pump. Multiple-piston pumps.
Flow control valves.	Rotary valve. Poppet valve. Spool or piston-selector valves. Restrictor valves. Orfice check valve. Check valves. Metering check valve. Sequence valve. Shuttle valves.

Topic and/or Operation	Related Information
Pressure-control devices.	Relief valve. Pressure regulators. Thermal relief valves. Debooster valve.
Accumulators.	Basic description or function. Diaphram-type accumulator. Bladder-type accumulator. Piston-type accumulator. Seal couplings.
Hydraulic fluids.	Purposes of hydraulic fluids. Hydraulic-fluid types. Rules for use of hydraulic fluid.
Hydraulic packing rings and seals.	Purpose. Seals and packings. Hydraulic tubing. Tube fittings. Installation of hydraulic tubing. Flexible hydraulic hose.
Hydraulic systems for aircraft.	System with pressure regulator or unloading valve. The open-center system. Light-plane hydraulic system.
<u>Unit XII: Aircraft Landing Gear</u> - 50 hours	
Classification of landing gear.	Main landing gear types: 1. Nonretractable (fixed) landing gears R-7, C-15. 2. Retractable landing gear 3. Skis and floats. Auxiliary landing gear: 1. Nosewheels 2. Tailwheels 3. Antishimming devices.

Topic and/or Operation	Related Information
	Shock absorbing devices: 1. Shock cord and coding 2. Spring gear 3. Spring oleo struts 4. Air-oil shock strut.
Retractable landing gear.	Main landing gear. Nose landing gear. Landing gear for light twin airplane. R-7, C-15.
Retraction test.	
Wheel hubs.	Types, material and construction. R-7, C-15. Grease and bearing retainers. Axle bearings.
Tires.	Types, material and construction. Treads and sizes. Tubeless and vents. Inflation, pressures and valves. Recapping methods. Maintenance and storage.
Tubes.	Material and size. Maintenance and storage.
Tube and tire installation.	Balancing and balance marks. Installation and inspection. Special tools and equipment. Safety precautions. Repair and vulcanizing.
Wheel removal and installation.	Jacking and precautions. Axle and bearing condition. Torque tightening sequence. Creep marks.
Inspection after heavy landing.	Procedure - general. Symmetry checks. Wheel alignment.
Installation and removal of skis and floats.	

Topic and/or Operation	Related Information
Unit XIII: Brake Systems - 20 hours	
Types of brakes, features and functions.	Classification. R-7, C-15. Shoe. Single and multiple disc. Expander tube. Lining material. Brake drums.
Master cylinder systems.	Typical layout. Types of master cylinders. R-7, C-15. Fluids and seals. Parking and emergency.
Power systems.	Typical layout. Power brake control valves. De-boosters. Parking and emergency.
Inspection and servicing.	Fluid levels. Adjusting brake clearance. System bleeding. Linkage adjustment. Pressure adjustment.
Trouble shooting.	Typical faults. Charts and rectification.

AIRCRAFT MAINTENANCE 32

(15 or 20 credits)

Topic and/or Operation	Related Information
Unit I: Electricity and Electrical Systems - 70 hours	
Electron theory.	Atomic structure. Current flow. R-5. Electrostatics. R-6. Safety precautions - bonding, grounding, etc.
Review of basic electricity.	Terms and definitions. Ohm's law.
Circuits.	Series, parallel and single wire. Voltage drop. Applications of Ohm's and Kirchhoff's laws.
Circuit checking.	Operation and use of meters. Continuity checks. Checks for shorts.
Cells, features and functions.	Primary. Secondary: 1. Acid 2. Alkaline. Batteries. Capacity and installation. Faults.
Battery servicing.	Charging methods. Checking S.G. of electrolyte. Filling cells. Terminal corrosion.
Electromagnetic induction.	Theory of magnetism. Applications of Lenz's law. Self inductance. Solenoids and relays.

Topic and/or Operation	Related Information
Direct current generators.	Theory, construction, features and functions. Residual magnetism and commutator ripple. Types and uses.
Direct current motors.	Theory, construction, features and functions. R-6. Counter and net E.M.F. Types and uses.
Maintenance and inspection of generators and motors.	Commutator checks and servicing. R-6. Circuit checks. Functional and balance checks. Installation and flashing the field.
Voltage regulation.	Principles of operation. Vibrator and carbon pile types. Current limiters. Reverse current cut-out relay.
Power circuits.	Aircraft battery. R-5. External power. Typical layouts.
Circuit protection.	Fuses and circuit breakers. R-5. Limitators and overload switches.
Circuits and cable installation.	Diagram symbols. R-5. Cable sizes, identification and wire codes. Conduits and shielding. Cable bundles and tying. Terminals, connectors and switches. Junction boxes and bonding. Lamps and sockets.

Topic and/or Operation	Related Information
Equipment installation.	D.O.T. procedure. R-3. Electrical load analysis. Calculations and reports.
Trouble shooting.	Typical layout and faults. R-6. Charts and rectification. Maintenance and inspection.
Magneto ignition.	Magneto construction. R-6. Principles of operation: 1. Induction 2. Lenz's law 3. Left hand rule. Primary electrical circuit. Breaker assemblies: R-6. 1. E-gap angle 2. Resultant flux curves 3. Primary capacitor 4. Compensated cams. High tension electrical circuit: R-6. 1. Transformer action of coil 2. Distributor-requirements a. timing b. insulation. Types of H.T. magnetos: R-6. 1. Flange and base mounted 2. Rotating magnet and inductor rotor 3. Single and double types.
(Disassembly and examination of a typical magneto)	Features of a typical H.T. magneto for a light aircraft, 4 or 6 cylinder. Low tension magnetos: R-6. 1. Reasons for development a. flashover b. capacitance c. moisture d. high voltage corona
Ignition boosters.	Coming-in speeds. R-6. Impulse couplings. Booster coils. Induction vibrators.

Topic and/or Operation	Related Information
Jet engine. (light coverage)	Requirements: (Pratt & Whitney, PT6 Engine Manual) 1. Altitude relight 2. Temperature range 3. Sparking rates, erosion. Components: 1. Exciter units 2. Compositor units 3. Ignitor plugs.
Ignition analyzing.	Analyzer installation and controls. R-6. Wave form interpretation.

Unit II: Aircraft Power Plants and Instrumentation - 50 hours

History and development.	Early types of internal combustion engines. R-6. Their adapation for aircraft power plants. Progress in development. Requirements of aircraft power plants: 1. Power to weight ratio. 2. Cost of manufacture and operation 3. High speed power 4. Frontal area and cooling 5. Reliability 6. Ease of maintenance.
Piston engine classification.	In-line: R-6. 1. Upright and inverted 2. Advantages and limitations. Opposed: 1. Four cylinder 2. Six cylinder 3. Advantages and limitations. Single-row radial: 1. Cylinder arrangement 2. Advantages and disadvantages. Double-row radial: 1. Cylinder arrangement 2. Power range 3. Advantages and disadvantages.

Topic and/or Operation	Related Information
	Geometrical rotary engines: 1. Advantages 2. Possible use for aircraft 3. Construction and operational flexibility.
Gas turbine engine classification.	Centrifugal type: R-6 1. Early development 2. Limitations. Axial flow type: 1. Single and multi-compressors 2. Front and rear fan engines 3. Characteristics and performance of different types. Turbo-props: 1. Centrifugal type 2. Axial flow type 3. Reduction gears 4. Propeller controls.
Principles of the internal combustion engine.	
The four stroke five event cycle.	Valve operation. R-6. Intake stroke. Compression stroke. Ignition event. Power stroke. Exhaust stroke.
The two stroke cycle. (light coverage)	Combination of strokes. R-6. Crankcase as part of the induction system. Comparison with four stroke engine. Advantages and disadvantages.
Energy.	Types of energy. R-6. Energy conversion: 1. Fuel-heat-mechanical.

Topic and/or Operation	Related Information
Work.	Forces: R-6 1. Cylinder pressures 2. Friction. Distance: 1. Piston stroke 2. Propeller R.P.M.
Horsepower.	Force, distance and time. R-6. Brake horsepower. Indicated horsepower. Friction horsepower. Mechanical efficiency. Thrust horsepower. Examples and calculations.
Cycle diagrams.	Piston displacement. R-6. Compression ratios: 1. Limitations 2. Efficiencies 3. Fuels. Construction and interpretation of indicator diagrams.
Dynamometers. (light coverage)	The prony brake: R-6. 1. Principles 2. Examples. Electrical types. Hydraulic types.
<u>Engine construction</u>.	
The crankcase.	Materials and construction features. Functions. Types of crankcase: 1. In-line engines 2. Opposed engines 3. Radial engines.
Cylinders.	Materials and construction features. Related components: 1. Valve guides 2. Valve seats 3. Spark plug bushings 4. Rocker arm supports.

Topic and/or Operation	Related Information
Pistons.	Materials and construction features. Types of pistons. Function: 1. Energy transfer 2. Piston speeds 3. Piston pressures and temperatures. Piston rings: 1. Types 2. Construction 3. Function. Piston pins: 1. Construction 2. Function and retainers.
Connecting rods.	Construction. Types: R-6. 1. Plain 2. Fork and blade 3. Master and articulating. Function.
Crankshaft.	Construction: R-6. 1. Main journals 2. Crank pins 3. Counterweights and dynamic dampers. Types: 1. Single throw - 360° 2. Double throw - 180° 3. Four throw - 180° 4. Six throw - 120°
Bearings.	Function. R-6. Plain bearings. Roller bearings. Ball bearings. Servicing and preservation.
Poppet valves.	Function. R-6. Intake valve: 1. Types 2. Construction. Exhaust valve: 1. Types 2. Construction 3. Cooling.

Topic and/or Operation	Related Information
Valve mechanisms.	Valve springs: 1. Function 2. Requirements 3. Washers and locks. Rocker arms: 1. Valve clearance adjustment 2. Lubrication and oil transfer 3. Bearings. Push-rods: 1. Function Tappets and guides: 1. Function 2. Lubrication and oil transfer. Cam followers and cam rings: 1. Function 2. Relative speeds 3. Cam shapes. Camshafts: 1. Construction and function 2. Lubrication and oil transfer.
Oil pumps and relief valves.	Types and functions. R-6. Capacities and adjustment.
Oil filters.	Types and function. R-6. Inspection and sediment analysis.
Typical oil systems.	Internal. External. Dry and wet sump.

Unit III: Engine Overhaul - 90 hours

General.	Reasons for overhaul. R-6. Establishment of overhaul periods: 1. Proof of reliability R-3. 2. Extensions of times 3. Types of operations 4. Recommendations of manufacturers and regulating agencies. Workmanship and quality control. Safe practices. Use of overhaul manuals. Management and organization.

Topic and/or Operation	Related Information
Engine shop layout.	Receiving and preliminary survey: 1. Inventory 2. Records. Disassembly and cleaning. Inspection. Repair and replacement. Assembly.
Disassembling engines.	Special tools. Propeller shaft "run out" checks. Major sub-assemblies. Identification and tagging of parts. Racking and disposal of parts. Recording damaged or failed parts.
Cleaning engine parts.	Degreasing: R-6. 1. Vapour method 2. Solvent washing. Stripping: 1. Decarbonizing solutions 2. Paint removers 3. Grit blasting 4. Reprotection. Safety precautions: 1. Protective clothing 2. Skin allergies 3. Ventilation 4. Clean work area.
Inspecting engine components.	Engine records. R-3. Special inspections and service bulletins. Critical areas: 1. High stress 2. High loads and wear 3. Overheating. Visual inspection. Magnetic inspection. Penetrant inspection.

Topic and/or Operation	Related Information
	Dimensional inspection: 1. Table of limits 2. Care and use of measuring equipment 3. Oversize and undersize replacement parts.
Reconditioning.	
Replace a damaged stud.	Identification of O/S studs. Stud extractors. Torque limits. Fitting helicoils.
Replace a worn bushing.	Types of fits. R-6. Arbor presses. Bore distortion and rectification.
Fit new piston rings.	Oversize rings and grooves. R-6. Clearances. Ring expanders.
Fit new valve seats.	Methods of removal. R-6. Methods of securing the seat. Special tools. Oversized parts.
Fit new valve guide.	Methods of removal. R-6. Refitting and reaming.
Grind a set of valves.	Safety precautions. R-6. Grinding speeds and cutting oils. Dressing the wheel. Procedure.
Lap valves to seats.	Lapping tools and compounds. R-6. Procedure. Leak testing.
Remove nicks, burrs, scores and scratches.	Types of approved abrasives. R-6. Oil stones. Thread chasers. Reprotection.

Topic and/or Operation	Related Information
Assemble engines.	C/h manuals. R-6. Sequence of operation. Corrosion prevention. Timing gears. Inspection "stage checks". Selective assembly. Identification of new components. Cleanliness. Torque limits. Completion of records.

Unit IV: Power Plant Systems - Installation and Testing - 90 hours

Valve timing.

Principles.	Functional requirements: R-6. 1. Volumetric efficiency 2. Engine power and R.P.M. 3. Reliability. Timing diagrams: 1. Typical construction 2. Power overlap 3. Valve lift, lead, lag and overlap. Relative crankshaft and piston position: 1. Piston velocities 2. Maximum crank angles 3. Minimum crank angles 4. Thrust loads. Valve clearances. Gear ratios: 1. Cam shafts 2. Cam gears.
Valve time on in-line engine	Setting the crankshaft: R-6. 1. Time-rite indicators 2. Piston position indicators 3. Timing discs and pointers. Setting the camshaft: 1. Valve clearances 2. Vertical drives and couplings. Timing checks.

Topic and/or Operation	Related Information
Valve time a radial engine.	Engine assembly: R-6. 1. Marked gear teeth 2. Vernier adjustment 3. Timing checks. Adjusting valve clearances: 1. Cam float 2. Firing order 3. Differential expansion 4. Sequence charts.
Principles of Carburetion.	
Metering systems.	The atmosphere: R-6. 1. Pressure 2. Temperature 3. Humidity. The venturi tube. The U tube. Air bleeds.
Combustion.	Requirements of aviation gasoline. R-6. Fuel-air ratios. Power/mixture relations. Energy of combustion. Flame rate limitations. Detonation and pre-ignition.
Fuel evaporation.	Rate of evaporation. R-6. Cooling effect and carburetor icing.
Float type carburetors.	
Air flow control.	Throttle valves: R-6. 1. Types 2. Power control 3. Air metering forces.
Fuel level control.	Fuel pressure requirements: R-6. 1. Gravity 2. Pump. Float mechanisms: 1. Floats 2. Needle valves and seats.

Topic and/or Operation	Related Information
	Location of float chamber: 1. Stable fuel flows 2. Single and double barrel carburetors.
Main metering system.	Main metering jet: R-6. 1. Location 2. Sizes. Discharge nozzle and air bleed: 1. Location 2. Types. Idling passage. Range of constant ratios.
Idling system.	Idling jet. R-6. Idling air bleed. Fuel discharge point. Idling adjustment. Idle cut-off devices.
Economizer systems.	Function. R-6. Types: 1. Needle type 2. Piston type 3. Manifold pressure operated type.
Accelerating systems.	Purpose. R-6. Accelerating wells. Types of pumps: 1. Direct mechanical 2. Moveable piston 3. Delayed action pumps 4. Automatic pumps.
Mixture control system.	Purpose. R-6. 1. Altitude compensation 2. Cruising - for economy. Types: 1. Back suction 2. Needle-direct suction 3. Air port type. Control: 1. Manual 2. Auto-manual.

Topic and/or Operation	Related Information
Pressure injection carburetor.	
Advantages.	Non-icing. Metering stability. Reduced vapour locks. Atomization.
Construction.	Throttle unit: R-6, C-4. 1. Venturis 2. Impact tubes 3. Throttle valve. Automatic mixture control: 1. Bellows unit 2. Contoured needle valve. Pressure regulator unit: 1. Diaphram pressure transmitters 2. The air metering force 3. The fuel metering force. Fuel control unit: 1. Metering jets 2. Idling fuel metering 3. Power enrichment 4. Cruise control.
Principles of operation.	The air metering force: R-6, C-4. 1. Regulated impact pressure 2. Boost venturi pressure 3. Air bleeds. The fuel metering force: 1. Metered fuel pressure 2. Unmetered fuel pressure. Accelerating devices. Discharge nozzles.
Types of pressure injection carburetors.	Bendix P.S. Series for small engines: R-6, C-4. 1. Operation. Bendix P.R. Series for large engines: 1. Operation.
Water injection.	Advantages. R-6, C-6. System components and function: 1. Regulators 2. Tanks and plumbing 3. Control circuits.

Topic and/or Operation	Related Information
Fuel injection systems.	
Continental continuous flow system.	Injector pump: R-6, C-6. 1. Positive displacement rotary vane 2. Relief valve and pressure regulator 3. Pump pressure V. Engine R.P.M. Fuel/air control unit: 1. Air control throttle valve 2. Throttle actuated fuel metering valve 3. Mixture control valve. Fuel manifold valve: 1. Pressurizing valve 2. Outlet ports. Fuel discharge nozzles: 1. Location 2. Fuel atomization 3. Air bleed. Adjustments: 1. Idling R.P.M. 2. Idling fuel/air ratio.
Bendix RS fuel injection system.	Airflow sensing system: R-6, C-5. 1. Impact and venturi pressures 2. Throttle valve 3. Regulating lever 4. Servo ball valve. Servo regulator unit: 1. Air and fuel diaphrams 2. Regulation of delivery passages. Fuel control system: 1. Idle valve 2. Manual mixture control. Distributor valve: 1. Idle cut off. Fuel pressure gauge: 1. Discharge nozzle fuel pressure 2. Correlated fuel flow 3. Power indicators.

Topic and/or Operation	Related Information
	Fuel discharge nozzles: 1. Location for unsupercharged and supercharged engines. Adjustment: 1. Throttle and mixture levers on their shafts 2. Idling R.P.M. 3. Idling mixture.
Ignition timing.	Internal timing: R-6. 1. Positioning the roter-E gap 2. Positioning the distributor 3. Timing marks 4. Adjusting contact breaker points. Timing magnetos to the engines: 1. Locating T.D.C. 2. Setting the magneto 3. Types of couplings 4. Synchronization.
Spark plugs.	Construction and function: R-6. 1. Classification 2. Materials 3. Heat range. Servicing: 1. Removal and preliminary inspection 2. Cleaning 3. Regapping and testing 4. Installation.
Engine trouble shooting.	Procedure.
Unit V: Propellers - 20 hours	
	Propeller theory. Propellers for light aircraft. Propellers for large aircraft. Propeller removal and installation. Propeller inspection and repair.

Topic and/or Operation	Related Information
Unit VI: Aircraft Systems - 70 hours	
Fuel System.	
Aviation fuels.	Composition. R-6, C-8. Grades and color classification and identification.
Systems features and functions.	Types of systems. R-6, C-8. Pumps, engine driven and other. Relief and by-pass valves. Strainers and drains. Tanks, tank requirements. Selectors, dump valves and fuel level indicators.
Installation and inspection.	Tanks, lines and supports. R-6 C-8. System checks. Tank and cell testing and repair. Safety precautions.
Typical systems.	Gravity feed. R-6, C-8. Force feed. Multi tank layout. Emergency systems.
Re-fueling.	Procedure: R-6, C-8. 1. Fire precautions 2. Bonding and static control 3. Fuel quantity indication 4. Water removal and checking 5. Pressure refueling.
Lubricants.	
Classification.	Animal, R-6, C-9. Vegetable. Mineral. Synthetic. Semi-solids. Fluid.
Properties of lubricating oils.	Viscosity: 1. Definition 2. Viscosity ratings: S.A.E. Commerical aviation 3. Viscosity index 4. Temperature effects 5. Oil dilution.

Topic and/or Operation	Related Information
	Flash and fire point: 1. Consumption rate 2. Contamination of used oils.
Function of lubricating oils.	
Greases.	Types of greases.
Heating and Ventilation Systems.	
Heating methods, features and functions.	Exhaust muff. R-7, C-16. Combustion heaters. Ram air and scoops. Mixing chambers. Ground blowers. Typical layouts.
Ventilation methods, features and functions.	Scoops. R-7, C-16. Vents. Outlets. Typical layouts.
Maintenance and inspection.	Functional and pressure checks. R-3. Testing of ducting. Routine checks.
Fire extinguisher systems.	
Aircraft and engine fires.	Causes and types. R-7, C-16. Fire safety design requirements. Fire risk areas.
Extinguishers.	Types. Seasonal care. Inspection methods. Maintenance.
Systems, features and functions.	Components. R-7, C-16. Discharge methods. Blow out discs. Smoke and fire warning. System operational tests. Typical layouts.

Topic and/or Operation	Related Information
<u>De-icing and Anti-icing System</u>.	
Ice formation.	Ice forming conditions. Types of ice formation.
Anti-icing methods, features and functions.	Heated leading edges. Chemical liquids. Alcohol spray, propellors and windshields. Typical systems and components.
De-icing.	Hot air. Distortion. Chemical liquid.
<u>Oxygen Systems</u>.	
Oxygen and the body.	Anoxia and its effects. Partial pressure effects. Explosive decompression.
System components - features and functions.	Basic requirements. R-6, C-16. Oxygen bottles fixed and portable. Face masks and regulators. Flow indicators. Typical systems.
Maintenance and inspection.	Special precautions. Line flushing. Functional and pressure tests.
<u>Pressurization and Air Conditioning</u>.	
Pressure cabins.	Design. R-6, C-16. Limits.
Systems components - features and functions.	Refrigeration units. Heating units. Control methods. Sealing. Emergency depressurization.

Topic and/or Operation	Related Information
System.	Flight operation. Typical layout.
Maintenance.	Functional tests. Ground pressure tests. Leak rates.
Water and Waste Systems.	
Water system.	Requirements. R-6, C-16. Types. Typical layout.
Waste system.	Requirements. Types. Typical layout.
Unit VII: Flight Controls and Rigging - 50 hours	
Control types and features.	Classification. Cable. Push-pull rods: 1. Torque tubes 2. Bell cranks 3. Walking beams. Bowden type. Teleflex type. Hydraulics and electrical.
Control inspection and servicing.	Control runs. Support. Lubrication. Wear limits. Safety features.
Control rigging. (using cable tensiometer)	Pulleys. Fairleads. Cable tension charts: 1. Temperature correction 2. Turnbuckle adjustment and locking 3. Tensiometer. Control movement: 1. Proper direction 2. Range of travel 3. Jig boards, inclinometers, protractors 4. Stops and adjustment.

Topic and/or Operation	Related Information
	Safety: 1. Dual inspection 2. Log entry 3. Locking devices 4. Protection (corrosion) 5. Wear protection.
Typical flight control systems.	Aileron and trim tab. R-4. Rudder and trim tab. Elevator and trim tab.
Flight control rigging changes after test flight.	Faults and correction: R-4. 1. Wing heaviness 2. Tail heaviness 3. Yawing.
Tie-down and mooring procedures.	Tie-down points. Cordage types. Knots and application. Seaplane mooring. Picketing landplanes.
Slinging procedures.	Types of slings. R-4. Lifting points. Use of slings. Maintenance of slings.
Jacking procedures.	Types of jacks used on aircraft. Jacking points. Precautions when jacking.
Aircraft cable.	Material and construction. R-4. Types and applications. Sizes and working loads. Inspection and storage.
Aircraft cable splicing.	Types of splices: R-4. 1. Wrapped and soldered 2. Hand woven 3. Micopress sleeves 4. Swaging terminal ends.

Topic and/or Operation	Related Information
	Procedures and tools. Inspection and protection. Strengths and proof loading. Cable fittings: 1. Turnbuckles 2. Terminal ends 3. Micopress sleeves 4. Coding of cable fittings.
Aircraft wire.	Types: 1. Locking 2. Streamline tie rods 3. Round tie rods. Materials and construction. Applications. Inspection, precautions, storage.
Assembly and rigging.	Airplane assembly: R-4. 1. Tools required 2. Precautions to avoid damage. Airplane rigging: 1. Tools and equipment 2. Leveling means 3. Rigging position 4. Measurement of wash-in and wash-out 5. Locking and safetying 6. Correction of rigging faults after flight test.
Unit VIII: Weight and Balance - 20 hours	
Weighing of aircraft.	Requirements and frequency of weighing. R-4, C-11. Procedure. Types of seals. Weight and balance report.
Center of gravity locating.	Terms and definitions. R-4, C-11. Theory of moments. Moment calculations. Permissable movement of C of G. Amendment of weight and balance report.

Topic and/or Operation	Related Information
Aircraft loading.	Disposition and tie-down. R-4, C-11. Loading charts and computers. Calculations. Weight changes in flight.
Unit IX: Rotary Wing Aircraft - 35 hours	
Theory of flight.	Types of rotorcraft, history: 1. Autogyro 2. Helicopter. Helicopter types: 1. Single main and tail rotors 2. Twin coaxial rotors 3. Twin tandem rotors 4. Twin intermeshed rotors. Helicopter aerodynamics: R-1. 1. Airfoil design 2. Forces on rotor blades 3. Coning 4. Tip path plane 5. Rotor disc effect 6. Disc loading. Hovering flight: R-1. 1. Pitch control a. collective b. cyclic 2. Ground effect and translational flight. Horizontal flight: R-1. 1. Dissymmetry of lift: a. articulated rotor i. flapping hinge ii. drag hinge and geometric imbalance. 2. Tilting the rotor disc: a. gyroscopic precession b. semi-rigid rotors. 3. Autorotation: R-1. a. principles b. procedures.
Rotor heads.	Construction, features and functions. R-10. Maintenance and inspection procedures.

Topic and/or Operation	Related Information
Rotor blades.	Types: R-10. 1. Wooden 2. Metal. Features and functions, construction methods. Inspection and limits. Repair schemes. Tracking procedures and balancing adjustments.
Controls and rigging.	Typical control systems. R-10. Rigging procedures (general). Trouble shooting (general).
Clutches.	Types and functions. R-10. Construction features. Inspection and servicing.
Gearboxes (transmissions).	Types and function. R-10. Construction features. Lubrication systems. Inspection and servicing.
Tail rotor drive system.	Types and function. R-10. Construction features. Universal joints and gear box. Rigging. Tracking and balancing T.R. Inspection and servicing.
Inspections.	Routine inspections. R-10. Special inspections: 1. Sudden stoppage 2. Abnormal or hard landing 3. Service bulletins.
Ground running the helicopter. (field trip)	Safety measures. R-10. Prestart inspection. Starting and running procedure. Clutch engagement procedure. Run-up checks. Shut-down procedure.

Topic and/or Operation	Related Information
Unit X: Air Regulations - 5 hours	
Air regulations pertaining to aircraft maintenance in Canada.	D.O.T. Engineering and Inspection Manual.

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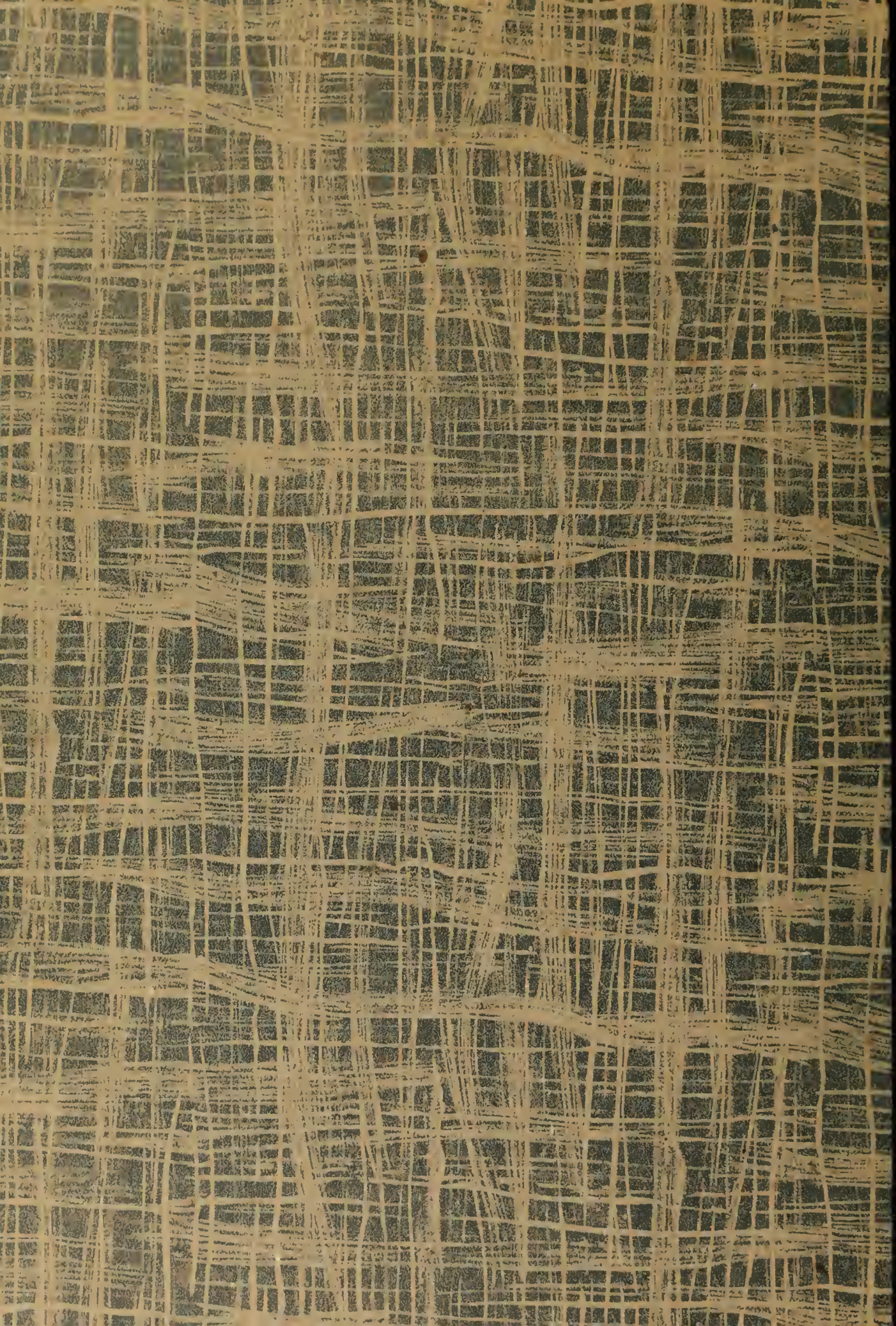
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